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SKYLAB EXPERIMENT PERFORMANCE EVALUATION MANUAL

Appendix O: Experiment TOO2 Manual Navigation Sightings (MSFC)

By K. S. Purushotham
Teledyne Brown Engineering Company
Huntsville, Alabama

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Prepared for

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812

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16. ABSTRACT

This appendix contains a series of analyses for Experiment T002, Navigation Sightings (MSFC), to be used for evaluating the performance of the Skylab corollary experiments under preflight, inflight, and post-flight conditions. Experiment contingency plan workaround procedure and malfunction analyses are presented in order to assist in making the experiment operationally successful.

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APPENDIX O. EXPERIMENT T-002, MANUAL NAVIGATION SIGHTINGS (MSFC)

May 1972

Prepared By:

K. S. Purushotham

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DEFINITION OF SYMBOLS

AM	Airlock Module
CM	Command Module
FBD	Functional Block Diagram
GMT	Greenwich Mean Time
OMSF	Office of Manned Space Flight
OWS	Orbital Workshop
P_{f_t}	Total probability of failure
TBD	To be Determined
TBS	To be Supplied
VCS	Ventilation Control System

SECTION I.

EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS

TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 1 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER*	REMARKS
	MIN.	NOM.	MAX.		
3.0 Analyze and predict the facet performance profile for Skylab Experiment T-002, Manual Navigation Sightings.				N/A	Refer to functional item 3.1.
3.1 Make explicit statements about objectives in qualitative and quantitative terms.				N/A	Refer to functional item 3.1.1.
3.1.1 Specify the time required for T-002 tasks to be performed:				N/A	Crew time is the time required to set up, perform, and stow the T-002 experiment. Reference documents 1, 2, 3, and 4.
• SL-1/SL-2 Mission					
--Crew Time		hr:min			
-Setup		00:05			
-Operation		18:35			
-Stowage		00:05			
• SL-3 Mission					
--Crew Time					
-Setup		00:05			
-Operation		18:35			
-Stowage		00:05			
• SL-4 Mission					
--Crew Time					
-Setup		00:05			
-Operation		18:35			
-Stowage.		00:05			

*Criticality Category Number Definition:

- Category I--Experiment and equipment whose failure could adversely affect crew safety.
- Category II--Experiment and equipment whose failure could result in not achieving a primary mission objective, but does not adversely affect crew safety.
- Category IIIa--Experiment and equipment whose failure could result in not achieving a secondary mission objective, but which does not adversely affect crew safety or preclude the achievement of any primary mission objective.
- Category IIIb--Experiment and equipment whose failure could not result in a loss of primary or secondary mission objectives and does not adversely affect crew safety.

TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 2 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.2 Specify the types of criteria that are to be maximized or minimized				N/A	The Functional Objectives (FO) of Experiment T-002 are: • FO-1 --*Perform* 6 sextant sighting periods on a pair of known stars for midcourse type navigation • FO-2 --Perform 12 sextant sighting periods on a known star and the lunar limb for midcourse type navigation • FO-3 --*Perform* 6 sextant sighting periods on two portions of the lunar limb for midcourse type navigation • FO-4 --Perform 2 stadimeter sighting periods on the earth horizon for orbit type navigation • FO-5 --Perform 3 sextant sighting periods on the earth horizon and a known star for orbit type navigation • FO-6 --Perform 5 sextant/stadimeter sighting periods consisting of sextant measurements on the earth horizon and two known stars and stadimeter measurements on earth horizon for orbit type navigation. Reference documents 1 and 5.
3.1.3 Specify the percentage of acceptable max./min. for each objective.	70.75%	85.37%	100%	N/A	The minimum acceptable 70.75 percent is derived as follows: • FO-1 --Perform a minimum of 4 midcourse type navigation sextant sighting periods on a pair of known stars. This constitutes 2/3 of the desired performance or 16.66 percent of the total objective. • FO-2 --Perform a minimum of 10 midcourse type navigation sextant sighting periods on a known star and the lunar limb. This constitutes 5/6 of the desired performance or 14.1 percent of the total objective.

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TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 3 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.3 (Concluded)					• FO-3 --Perform a minimum of 4 midcourse type navigation sextant sighting periods utilizing sightings on two portions of the lunar limb. This constitutes 2/3 of the desired performance or 5.3 percent of the total objective. • FO-4 --Perform 2 orbit type navigation stadimeter sightings utilizing earth's horizon. This constitutes 10 percent of the total objective. • FO-5 --Perform a minimum of 2 orbit type navigation sextant sightings utilizing earth's horizon and a known star. This constitutes 2/3 of the desired performance or 6.66 percent of the total objective. • FO-6 --Perform a minimum of 3 orbit type navigation sextant/stadimeter sightings utilizing various combinations of earth's horizon and known stars. This constitutes 3/5 of the desired performance or 18 percent of the total objective. The above values are subjective estimates.
3.1.4 Specify experiment constraints: • Musts • Must Nots • Wants • Don't Wants.				N/A	• Musts --All sextant sightings must be conducted during the night portion of the orbit --Moon must be visible from the wardroom window for 18 of the sextant performance periods --For orbital sightings using the sextant, the earth's horizon must be visible from the wardroom window --External lights that affect viewing from the wardroom window must be off during the experiment performance --Wardroom interior lights must be dimmed during the experiment performance to allow the crew to view starfields --During the stadimeter operational sighting, the 3 performances must be 15 min apart. • Must Nots --There must not be any waste dumps during the experiment performance --Experiment T-002 and S-063 must not be scheduled concurrently. • Wants --For midcourse type navigation measurements, the performances should be distributed equally in time throughout the mission so that a trend analysis may be performed on the data.

TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 4 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.4 (Concluded)					• Don't Wants --N/A Reference documents 2 and 3.
3.1.5 Specify the experiment tolerances: • Musts • Must Nots • Wants • Don't Wants.				N/A	Refer to functional item 3.1.4. Specific tolerances for each constraint in functional item are TBD.
3.2 Define decision rules and success criteria for experiment objectives.				N/A	If the experiment is aborted, then the probability of success (P_s) is equal to 0.0. If the experiment is compromized and minimum information is salvaged, $P_s = 0.1 \rightarrow 0.5$; if the maximum information is salvaged, $P_s = 0.5 \rightarrow 0.9$. If the experiment is completed as scheduled, $P_s = 1.0$. These values are subjective estimates.
3.3 Specify the experiment priority (numerical statement) for a given Skylab flight designation.				N/A	Experiment T-002 (FO-1 through FO-6) will be scheduled on SL-1/SL-2, SL-3, and SL-4 missions, at the convenience of the crew and on a noninterference basis with the other experiments. The experiment priority number is 100. Reference document 1.
3.4 Briefly describe and list the major subsystems for Experiment T-002.				N/A	Refer to functional items 3.4.1 and 3.4.2.
3.4.1 Describe the major functions.				N/A	Experiment T-002 is designed to investigate the effects of the space environment (including long mission time) on a navigator's ability, using hand-held instruments, to obtain space navigation measurement through a spacecraft window. In addition, the experiment will demonstrate the operational feasibility of a manual navigation system consisting of a hand-held sextant and stadimeter. The experiment objective will be met by making both midcourse type and orbit type measurements during the performance of this experiment. Midcourse type navigation measurements will be made during the dark portion of the orbit using star/lunar limb target combinations. Measurements of the angle between selected star pairs will also be made. Orbit type navigation measurements, using a hand-held sextant and a hand-held stadimeter, will be made using stars and earth's horizon as targets. The measurements and other data obtained from both type navigational measurements will be voice recorded and dumped to the ground for subsequent analysis. Reference documents 2, 3, and 6.

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TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 5 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.4.2 List the major components.				N/A	The major subsystem components are: • Sextant • Stadimeter • Stopwatch • Temperature Indicator • Battery Stowage Case • Hood • Chronograph • Star Charts • Storage Module.
3.5 Define the T-002 experiment/ carrier subsystem interface: • Physical --Mechanical --Electrical --Communication and Data --Support • Environmental --Natural and Induced --Contamination • Operational --Pointing and Control --Crew Safety --Sequence --Operability				N/A	A set of Functional Block Diagrams (FBD) is submitted as Figure O-1, and is used as a subsystem component listing. Critical subsystem components will be identified and evaluated for failure, and correlated to possible experiment/carrier interface problems. Reference documents 3 and 6.
3.5.1 Sextant.				N/A	Refer to functional item 3.5.1.3.

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TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 6 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.3 Specify the total probability of failure (P_{f_t}) of the scanning mechanism.		0.1		IIIb	The scanning mechanism consists of: • Course Scan Control • Fine Scan Control • Shafts • Gears • Bearings. The scanning control is used to control the angular rotation of the scanning line of sight. The control knobs are located on the left hand side of the instrument. When the knob is rotated, the torque is transmitted through shafts and gears to the mirror. A full revolution of course knob advances the scanning mirror 2 1/2° (equivalent to 5° of motion of scanning line of sight). A full revolution fine control knob advances the scanning mirror 1° in optical motion. Internal to the knob is a series of tongued washers that build up to provide mechanical stops to the scanning mirror motion. The washers are preselected to provide 38° of mirror angular travel, or maximum angular line of sight separation. The probability of failure of this mechanism is considered to be very small. If the mechanism should fail, the following could occur: • Mechanical --If the gears are binding, it would be difficult to scan the mirror. --Bearing seizure would make it impossible to operate the mirror scanning knob. The following indications can be used to determine the failure of the scan control mechanism: • Tight rotation of the scan control knob indicates that the gears are binding. • If the knob does not rotate, it indicates that the bearings are frozen. Reference documents 3 and 6.
3.5.1.6 Specify P_{f_t} for the mechanical counter.		0.1		IIIb	The data readout is a mechanical counter located on the front face of the sextant. The angle between the scanning line of sight and the fixed line of sight is indicated by the counter and reads in degrees and thousandths of a degree. The drive shaft is directly coupled to the last drum so that one full revolution of the shaft will advance the counter by six arc min. The marking on the last drum is in 0.001° increments or 3.6 sec of arc.

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TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 7 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.6 (Concluded)					The probability of failure of the counter is very small. If the counter mechanism should fail, the following situation could occur: • Mechanical --Broken gears of the counter drive mechanism could cause a failure. It would be impossible to record changes in angular measurements. The following indication could be used to determine the failure of the mechanical counter. • Rotate the scan control knob and observe the mechanical counter. If there is no change in the readings, it indicates that either the counter drive gears are not meshing or the drive shaft gears are not meshing with the counter drive gear. Reference documents 3 and 6.
3.5.1.7 Specify the Pf_t for the counter lamps.		0.1		IIIb	The lamps illuminate the counter. Power is obtained from a self-contained rechargable nickle-cadmium battery and requires 2.5 V nominal to operate the counter lamps. If the lamps should fail, the following situation could occur: • Electrical --It would be difficult to verify the readout on the counter. This experiment could be continued with the use of an auxiliary light. The following indication could be used to determine the failure of the counter lamp: • When the switches for both reticle and counter lights are turned on, both of them should illuminate. If the counter lamp fails to illuminate, this indicates a failure of the lamps or circuitry. Reference document 6.
3.5.1.8 Specify Pf_t for the counter illumination switch.		nil		IIIb	The counter illumination switch is a push button type and is located on the left hand side of the stadimeter. This switch turns the counter illumination lamp on or off. The probability of switch failure is considered remote. If the switch should fail, the following situation could occur: • Electrical --If the switch fails, it would be difficult to read the counter. However, an auxiliary light source could be used to read the counter.

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TABLE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 8 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.8 (Concluded)					The following indication could be used to determine the switch failure: • It is impossible to determine whether the switch or the lamps have failed. Reference document 6.
3.5.1.10 Specify the Pf_t for the reticle lamps.		nil		IIIb	These lamps illuminate the reticle and are located inside the sextant. The illumination level is controlled by a four position control switch. If the lamps should fail, the following situation could occur: • Electrical --It would be difficult to view the target sighted. The following indication could be used to determine the failure of the reticle lamps: • The reticle should illuminate with the switch turned on. The failure of the lamps to illuminate in any position of the switch is an indication that the lamps have failed. Reference document 6.
3.5.1.11 Specify the Pf_t for reticle illumination control switch.		nil		IIIb	This is a four-position switch located on the left hand side of the instrument. It controls the illumination level of the reticle. The probability of failure of this switch is remote. If this switch should fail, the following situation could occur: • Electrical --See functional item 3.5.1.10. The following indication could be used to determine the failure of the switch: • It is impossible to determine the total failure of the switch. However, if the lights come on in one or two positions of the switch, it indicates that the switch has partially failed. Reference document 6.

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TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 9 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.13 Specify the P_{f_t} for scanning line of sight filter control.		nil		IIIb	These filters are provided to reduce the amount of light transmitted through the scanning line of sight. The filters, placed over the scanning line of sight, are of neutral density 1.0 and 1.3. The probability of failure of this mechanism is remote. If this control should fail, the following situation could occur: • Mechanical --Jamming of gears on the filter countrol gears could prevent the movement of the filter. However, the experiment could be performed without the use of the filter. The following indication could be used to determine the failure of the filter control mechanism: • Tight movement of the control lever is an indication that the mechanism gears are binding. Reference document 6.
3.5.2 Stadimeter.				N/A	Refer to functional item 3.5.2.1.
3.5.2.1 Specify P_{f_t} for the telescope lenses.		nil		IIIb	These lenses are located inside the stadimeter telescope system and are used to control the light rays for the proper incidence on the mirror. These lenses are color coated. It is estimated that the probability of failure of the lenses is remote. If the lense should fail, the following situation could occur: • Environmental --Radiation may affect the coatings on the lenses. This could affect the optical quality of the lenses and thus affect the accuracy of the experiment results. Reference document 6.
3.5.2.3 Specify the P_{f_t} for the mirrors.		nil		IIIb	The mirrors are located inside the stadimeter and are used to redirect the light rays to the proper entrance point in the prism cluster. It is estimated that probability of failure for the mirror is nil. If the mirrors should fail, the following situation could occur: • Environmental --There is a possibility that the radiation could affect the mirror coatings. This could seriously affect the quality of the mirror and affect the performance of the experiment.

TABLE O-I. EXPERIMENT T-002, NAVIGATION SIGHTINGS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 10 of 10)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.2.3 (Concluded)					Reference document 6.
3.5.2.5 Specify P_{f_t} for the scanning control mechanism.		0.1		IIIb	Refer to functional item 3.5.1.3.
3.5.2.6 Specify P_{f_t} for the mechanical counter.		0.1		IIIb	Refer to functional item 3.5.1.6.
3.5.2.7 Specify P_{f_t} for the counter lamps.		0.1		IIIb	Refer to functional item 3.5.1.7.
3.5.2.8 Specify the P_{f_t} for the counter illumination switch.		nil			Refer to functional item 3.5.1.8.
3.5.2.10 Sepcify the P_{f_t} for the reticle lamps.		nil		IIIb	Refer to functional item 3.5.1.10.
3.5.2.11 Specify the P_{f_t} for the reticle illumination switch.		nil		IIIb	Refer to functional item 3.5.1.11.
3.5.2.12 Specify the P_{f_t} for the scanning line of sight filter control.		nil		IIIb	Refer to functional item 3.5.1.13.

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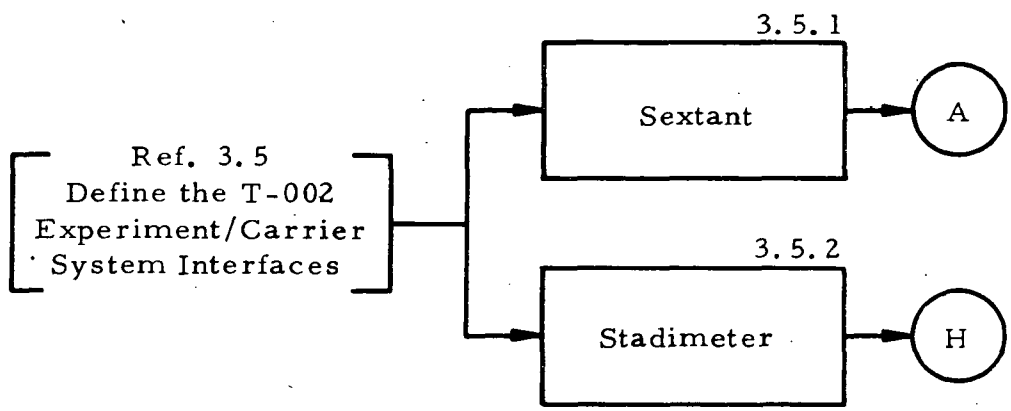


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 1 of 7)

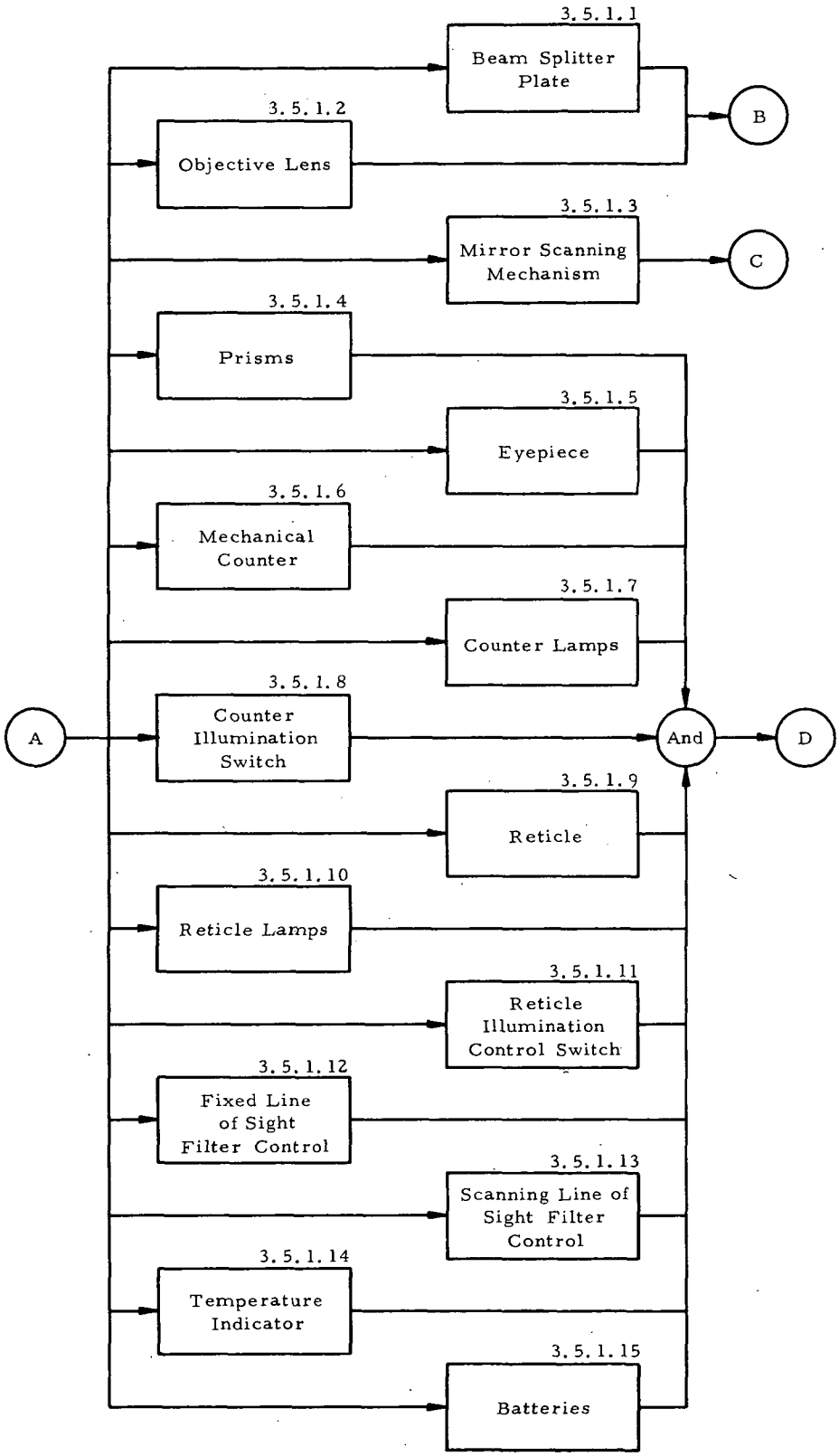


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 2 of 7)

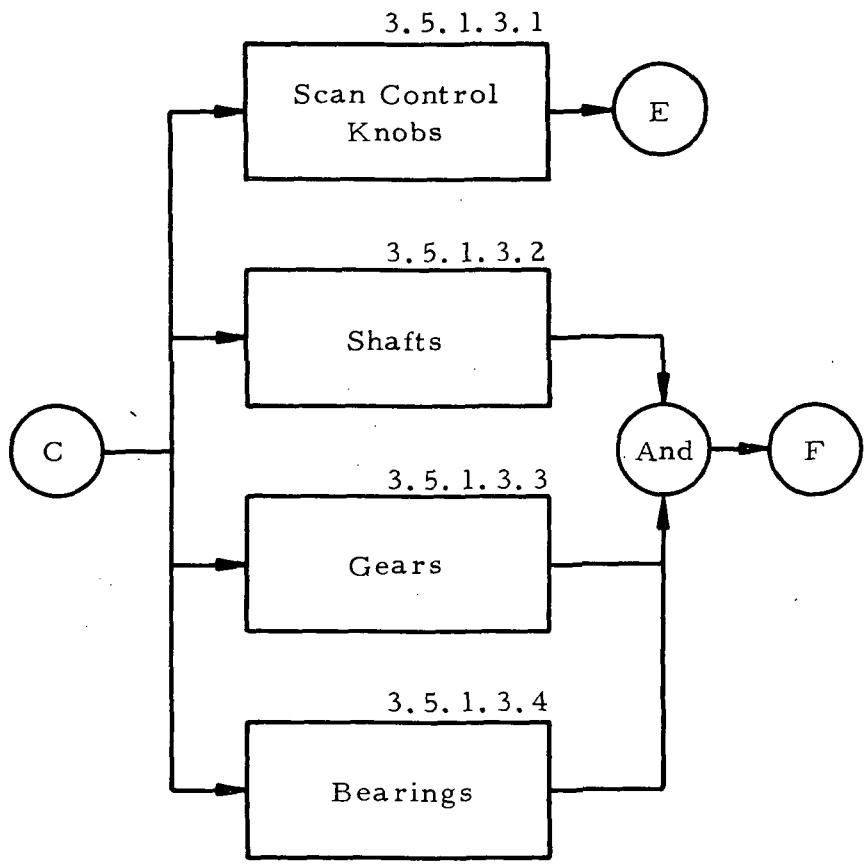


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 3 of 7)

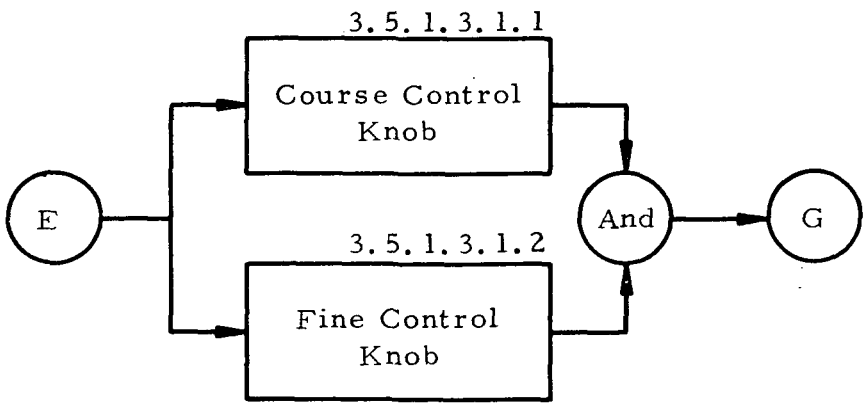


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 4 of 7)

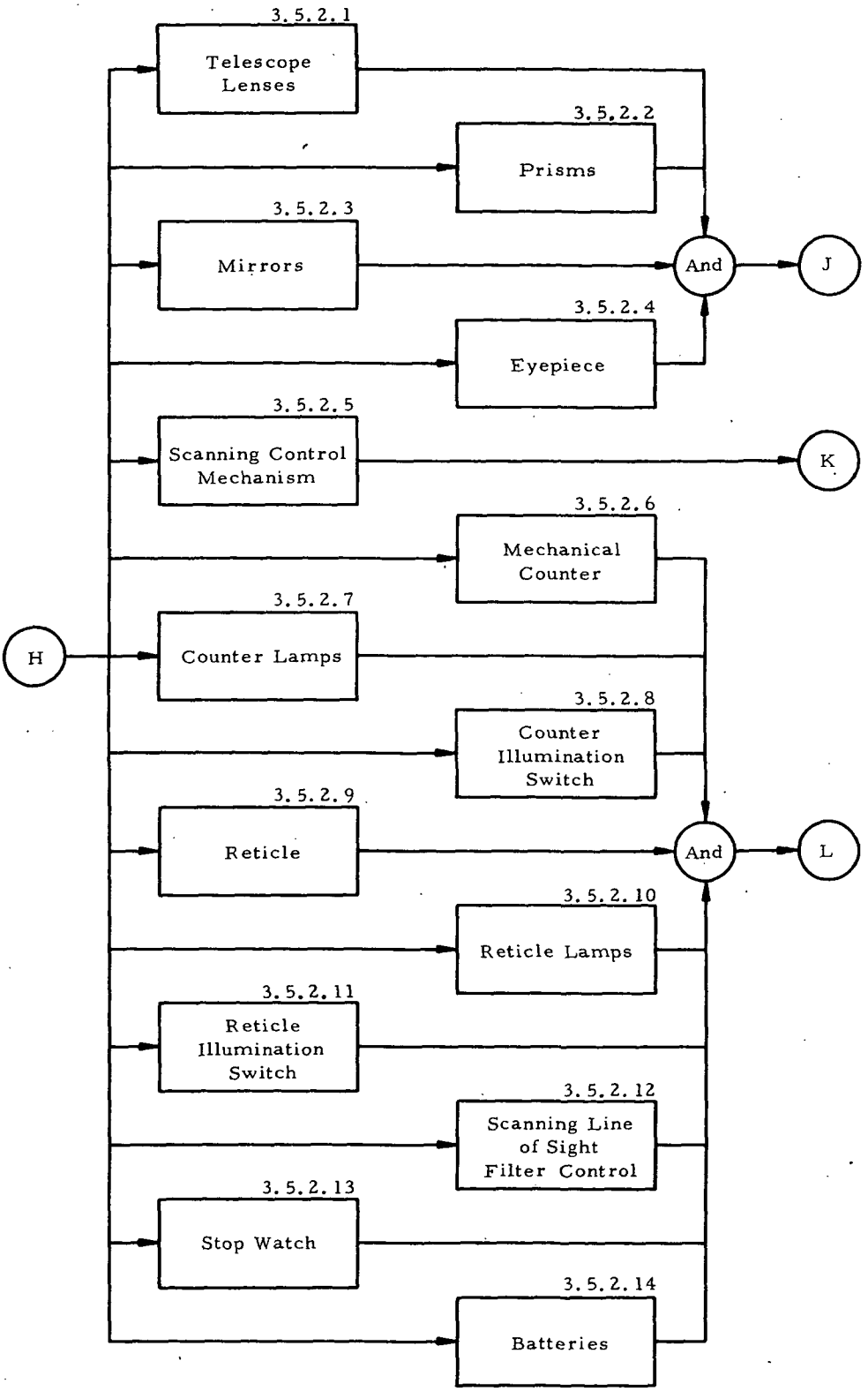


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 5 of 7)

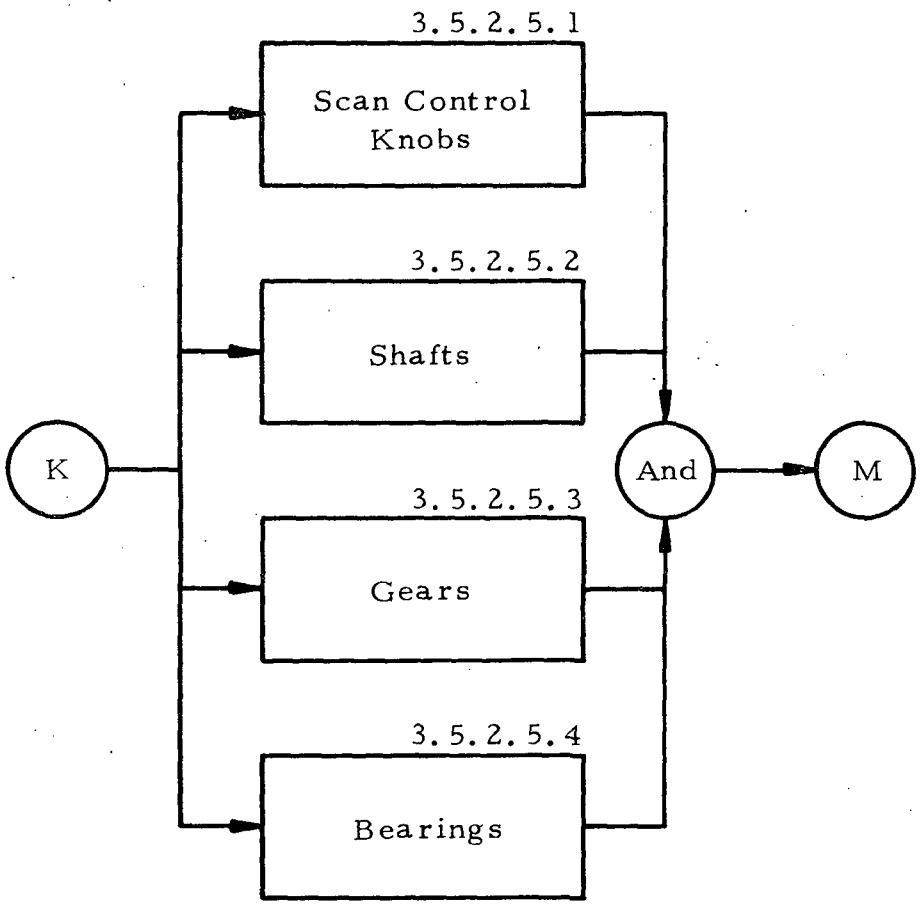


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 6 of 7)

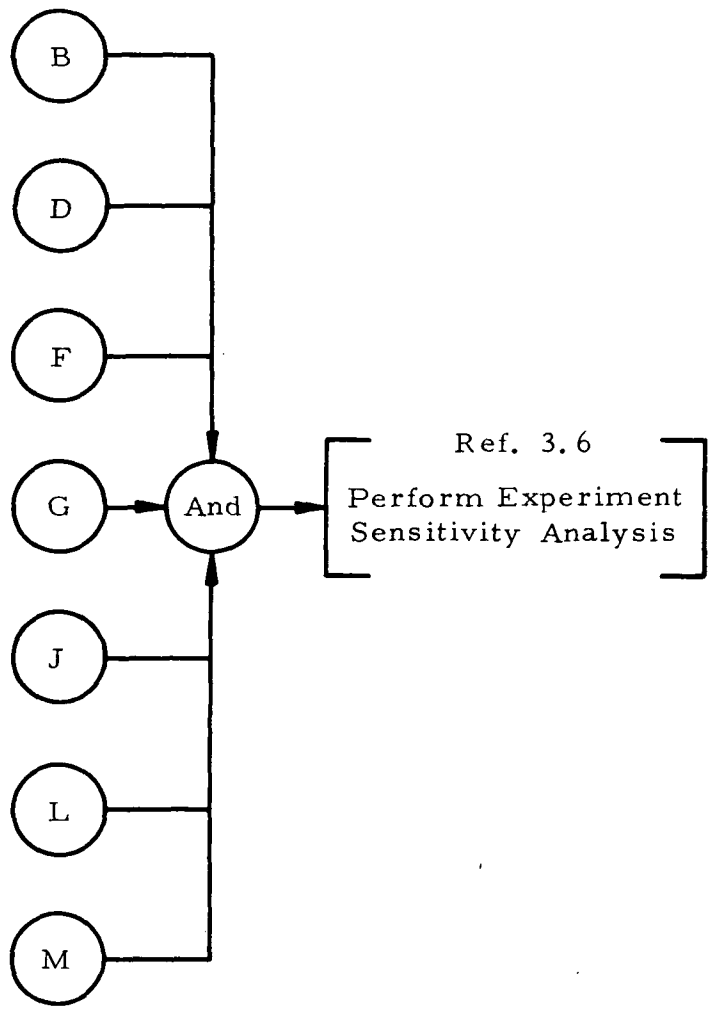
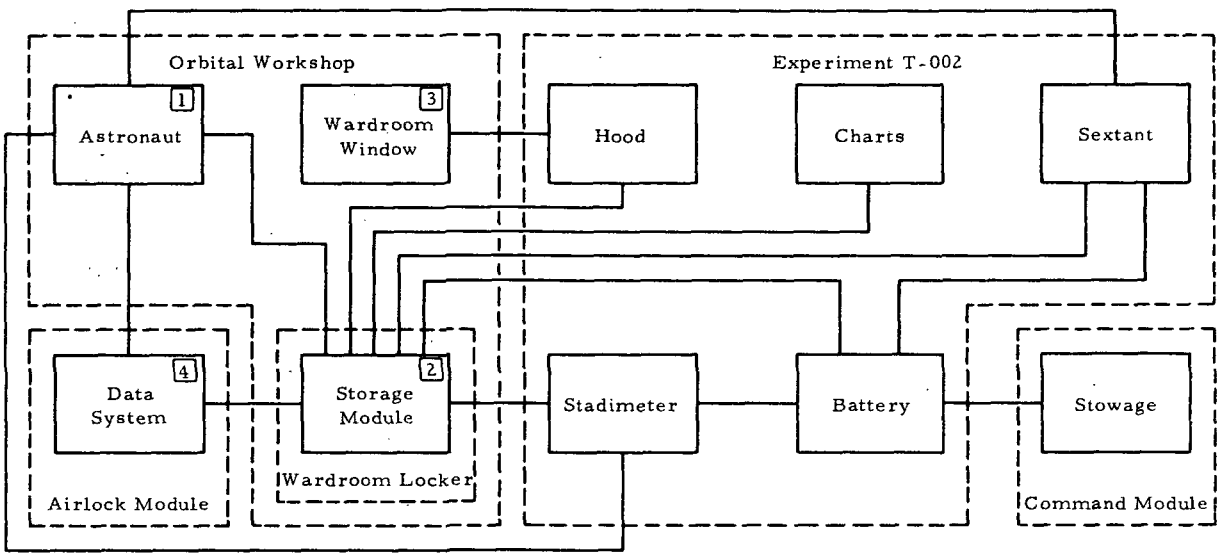


FIGURE O-1. EXPERIMENT T-002, NAVIGATION SIGHTINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 7 of 7)

SECTION II.

EXPERIMENT T-002, NAVIGATION SIGHTINGS INTERFACE BLOCK DIAGRAM



Code	Data Source	Remarks
1	Crew	There is an operability interface between the astronaut and the sextant/stadimeter. The astronaut will hand hold the sextant or stadimeter and view through the wardroom window to observe the target.
2	Crew	The storage module interfaces with the sextant, stadimeter, charts, hood, batteries and the crew. During lift-off, the above items are stowed in the wardroom locker along with the experiment storage module.
3	D7111-436 D237-520 C7144-438 C7164-438 C7293-443 C7294-443	There is a mechanical interface between the wardroom window and the hood. The hood prevents any internal light from interfering with the observation of the target. The wardroom window has an environmental interface with the Orbital Workshop (OWS) atmosphere. The environmental data is very necessary for the ground control to determine the wardroom atmospheric conditions.
4	Crew	There is a communication interface between the astronaut and the Airlock Module (AM) data system. Crew comments and experiment data are transmitted from the OWS wardroom voice communication box to the AM data recording system and dumped to the ground.
5	Crew	There is a mechanical interface between batteries and the Command Module (CM) stowage. The batteries and the stowage case is stowed during launch in the CM stowage area.

FIGURE O-2. EXPERIMENT T-002, NAVIGATION SIGHTINGS INTERFACE BLOCK DIAGRAM AND DEFINITION

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Experiment T-002, Navigation Sightings Systems Diagram TBS.

TABLE O-II. EXPERIMENT T-002, NAVIGATION SIGHTINGS DATA REQUIREMENTS SUMMARY

Measurement Name	Range and Dimension of Variable	Measurement Number	Telemetry Assignment Channel	Data Return	Data Time	Remarks
• Astronaut Voice Comments and Recording						
--GMT of sightings	TBD	N/A	N/A	Intermittent	Real	
--Target used	TBS	N/A	N/A	Intermittent	Real	
--Window line of sight location	TBD	N/A	N/A	Intermittent	Real	
--Temperature	N/A	N/A	N/A	Intermittent	Real	
--Instrument readout	N/A	N/A	N/A	Intermittent	Real	
--Voice "mark" for each target alignment	N/A	N/A	N/A	Intermittent	Real	
--Diopter setting	N/A	N/A	N/A	Intermittent	Real	
--Reticle brightness	N/A	N/A	N/A	Intermittent	Real	
--Stopwatch and chronograph readings	N/A	N/A	N/A	Intermittent	Real	
--Filter readings	N/A	N/A	N/A	Intermittent	Real	
• Vehicle Attitude (X, Y, Z Axes)	TBD	K382-702	TBD	Continuous	Real	
• Attitude Rates (X, Y, Z Axes)	TBD	K382-902	TBD	Continuous	Real	
• OWS Habitation Pressure	0 to 8 psia 0 to 5 Vdc	D711-436	WP1B074A25HE47	Continuous	All	
• Oxygen Partial Pressure	0 to 330 mm Hg 0 to 5 Vdc	D237-537	WP1B064A13HO78	Continuous	All	
• Ventilation Control System (VCS) Wardroom Inlet Temperature	40 to 100 °F 0 to 20 mVdc	C7144-438	WP1A150A52LO21	Continuous	All	
• VCS Duct No. 1 Outlet Temperature	40 to 100 °F 0 to 20 mVdc	C7164-438	WP1B104A06LB02	Continuous	All	
• Wardroom Window Retainer Temperature	0 to 120 °F 0 to 20 mVdc	C7293-443	WP1A050A87LH29	Continuous	All	
• Wardroom Window Doubler Temperature	0 to 120 °F 0 to 20 mVdc	C7294-443	WP1B010A05LH01	Continuous	All	
• Log Book	N/A	N/A	N/A	N/A	TBD	

DATA REQUEST FORM Skylab Program	DRF Control No.	Date 3-29-72
	Exp/Sys No. ASTN-SDI/OWS/T-002	Revision

Mission	Period of Interest	Op. Need Date	Rev Date
SL-1/SL-2, SL-3, SL-4	Flight/Experiment Manned		

Request Contact		Data Recipient		Date Req
Name	E. Fleischman	Name	W. R. Bock	Real Time
Organization	MSFC, PM-MO-I	Address	MSFC, S&E-ASTN-SDF	Qty
Phone	205-453-3657	Phone	205-453-3810	1

Reference Document:

MRD Content

Detailed Requirements:

Voice transcripts of astronaut comments are needed from Manned Spacecraft Center (MSC) for all T-002 experiment activities. The transcripts should be made available to S&E-ASTN-SDI as soon as possible after the experiment startup.

One copy of the Astronaut Log is needed after the completion of SL-1/SL-2, SL-3, and SL-4 missions.

Comments & Explanation:

Originator	Integrator
Name Organization Phone Signature Date	Name J. R. Riquelmy Organization MSFC, S&E-ASTN-SDF Phone 205-453-3810 Signature Date
Request Aproval	**Implementing Agency**
Name Organization Phone Signature Date	Name Organization Phone Signature Date

MSFC - Form 65 (October 1970)

DATA REQUEST FORM

Skylab Program

	DRF Control No.		Date 3-29-72
	Exp/Sys No. ASTN-SDI/OWS/T-002		Revision
Mission SL-1/SL-2, SL-3, SL-4	Period of Interest Flight/Experiment Manned	Op. Need Date	Rev Date

Request Contact	Data Recipient	Date Req
Name E. Fleischman Organization MSFC, PM-MO-I Phone 205-453-3657	Name W. R. Bock Address MSFC, S&E-ASTN-SDF Phone 205-453-3810	Real Qty

Reference Document: ERD: T002, SE-010-037-2H, 8-9-71, RFP: MSC-03625, 9-27-71

MRD Content

Detailed Requirements:

The Payload Integration Section (S&E-ASTN-SDI) needs to assess the level of housekeeping data for Experiment T-002, Navigation Sightings. The data are needed 10 min before the experiment, once during the midpoint of the performance, and at the end of the experiment.

A hard copy of the data should be made available to the user.

Comments & Explanation:

These data will be used to measure and evaluate the experiment carrier interfaces so that Skylab Mission evaluation reporting requirements can be fulfilled (See OMSF Program Directive 55 M-D ML, 138, 5-71).

Originator	Integrator
Name K. S. Purushotham Organization Teledyne Brown Eng., ASD-SHI Phone 205-532-1561 Signature [signature] Date 4/25/72	Name J. R. Riquelmy Organization MSFC, S&E-ASTN-SDF Phone 205-453-3810 Signature Date
Request Aproval	**Implementing Agency**
Name Organization Phone Signature Date	Name Organization Phone Signature Date

MSFC - Form 65 (October 1970)

DRF Contrl No.	Exp/Sys No.	Revision	Date
	ASTN-SDI/OWS/T-002		3/29/72

Detailed Requirements:

MEASUREMENT NO.	MEASUREMENT NAME
K382-702	Vehicle Attitude (X, Y, Z Axes)
K382-702	Attitude Rates (X, Y, Z Axes)
D7111-436	OWS Habitation Pressure
D237-537	O_2 Partial Pressure
C7144-438	VCS Wardroom Inlet Temperature
C7164-438	VCS Duct No. 1 Outlet Temperature
C7293-443	Wardroom Window Retainer Temperature
C7294-443	Wardroom Window Doubler Temperature

Engineering Change Requests for Experiment T-002 are N/A.

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 1 of 7)

Assignments

Mission:

- SL-1/SL-2, SL-3, and SL-4

Oribital Assembly

- OWS

Carrier

- The wardroom window is located between position II and III at OWS Station 409.5.62

Conditions

Crew:

- The pilot sets up, operates, and stows the experiment.

Experiment:

- This experiment is performed at crew convenience
  --Power: 2.5 V supplied by self contained batteries
  --Preparation Phase: TBD hr
  --Operation Phase: TBD hr
  --Termination Phase: TBD hr.

Ground Support

- Prelaunch: N/A
- Post-launch: N/A

Requirements

Functional Objectives:

- FO-1 through FO-6 are to be accomplished in SL-1/SL-2 mission. Those functional objectives or parts thereof scheduled and completed in the previous mission will not be repeated in the subsequent missions.

Experiment Evaluation Team - Key Personnel Locator

Name	Responsibility	Office Address, Symbol, and Telephone Number
Mr. R. Randle	Principal Investigator (PI)	Ames Research Center, Moffitt Field, California, 415-961-2529
Mr. L. Polaski	Experiment Developer (ED)	Ames Research Center, Moffitt Field, California, 415-961-2663
Mr. William Jenkins	MSFC Experiment Manager (EM)	MSFC, Bldg. 4201, PM-SL-DP, 205-453-3182
Mr. Walt Gillespie	S&E Integration Engineer (IE)	MSFC, Bldg. 4610, CSE-AE, 205-453-2785
N/A	S&E Experiment Engineer (EE)	N/A
Mr. W. R. Bock	Technical Discipline Manager (TDM)	MSFC, Bldg. 4610, S&E-ASTN-SDF, 205-453-3810
Mr. K. S. Purushotham	Experiment Operations Engineer (EOE)	Teledyne Brown Engineering Company, Huntsville, Alabama, ASD-SHI, 205-532-1561
Mr. A. A. Flowers	Mission Operations Design Support (MODS)	Martin Marietta Corporation, Huntsville, Alabama, 205-837-1820, ext. 230
Mr. R. Danner	Experiment Integration Engineer (EIE)	Martin Marietta, Denver Division, Denver, Colorado, 303-794-2094
Mr. Larry Keyser	Experiment Flight Controller (EFC)	Manned Spacecraft Center, Bldg. 30 FC-2, Houtson, Texas, 713-483-4616

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 2 of 7)

Operation Step Number*	Data: Return: Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Function**	Frequency***	Range and Dimension of Variables	Limits of Concern	Evaluation: Check: Satisfactory	Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Remarks
P - 60 min GMT for SL-1/ SL-2; GMT for SL-3; GMT for SL-4	Experiment Evaluation Team manned and available. Contact Experiment T-002, Technical Discipline Manager, S&E-ASTN-SD: HOSC Telephone No. TBD, Astronautics Laboratory Telephone No. 205-453-3810.											
	Reference: Skylab Flight Plan, SL-1/SL-2, SL-3 and SL-4, Summary Timelines, MSC-03625, latest revision, and Skylab Experiment Operations Handbook, Volume II: Experiment Operational Procedures, MSC.											
P - 10 min GMT for SL-1/ SL-2 GMT for SL-3; GMT for SL-4	Commence experiment preparation (ground action).											
P 1.0	Determine experiment status.											
P 1.1	Acquire status and evaluate the performance of the following measurements:											
	TBS	Vehicle Attitude		H	C	Range: TBD						
		K382-702	TBD			Read: TBD						
	TBS	Attitude Rates (X, Y, Z Axes)		H	C	Range: TBD						
		K382-702	TBD			Read: TBD						

*P - Preparation
O - Operations
T - Termination
L - Lift-off Booster

**E - Event
H - Housekeeping
A - Analog
D - Digital

***C - Continuous
I - Intermittent
D - Discrete (Specified number of times)

****R - Real Time
N - Near/Real Time
A - All Time

ASTN-72-1-OT (Jan 72)

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 3 of 7)

Operation Step Number*	Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Function**	Frequency***	Range and Dimension of Variables	Limits of Concern	Data Return / Evaluation Check: Satisfactory	Data Return / Evaluation Check: Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
P 1.1 (Concluded)	TBS	OWS Habitation Pressure		H	C	Range: 0 to 8 psia						
		D7111-436	WP1B074A25HE47			Read: 5 psia						
	TBS	O_2 Partial Pressure		H	C	Range: 0 to 330 mm Hg						
		D237-537	WP1B064A13HO78			Read: TBD						
	TBS	VCS Wardroom Inlet Temperature		H	C	Range: 40 to 100 °F						
		C7144-438	WP1A150A52LO21			Read: TBD						
	TBS	VCS Duct No. 1 Outlet Temperature				Range: 40 to 100 °F						
		C7164-438	WP1B104A06LB02	H	C	Read: TBD						
	TBS	Wardroom Window Retainer Temperature				Range: 40 to 100 °F						
		C7293-443	WP1A050A87LH29	H	C	Read: TBD						
	TBS	Wardroom Window Doubler Temperature				Range: 40 to 100 °F						
		C7294-443	WP1B010A05LH01	H	C	Read: TBD						

* P - Preparation
O - Operations
T - Termination
L - Lift-off Booster

** E - Event
H - Housekeeping
A - Analog
D - Digital

*** C - Continuous
I - Intermittent
D̄ - Discrete
(Specified number of times)

**** R - Real Time
N - Near/Real Time
Ā - All Time

ASTN-72-1-OT (Jan 72)

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 4 of 7)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
P - 0 min GMT for SL-1/SL-2; GMT for SL-3; GMT for SL-4	Commence experiment preparation flight action.					
P 2.0	PLT	Remove the protective shield from the window and stow.				
P 2.1	PLT	Unstow the hood and install it on the window.				
P 2.2	PLT	Remove sextant/stadimeter from the stowage container.				
P 2.3	PLT	Install new batteries if required.				
P 2.4		Focus the instrument eyepiece and voice record the diopter setting.				
P 2.5	PLT	Dim the interior lights near the experiment operation.				
P 2.6		Turn the instrument readout lamps on.			P26A1 P26B1 P26C1	
P 2.7		Turn the reticle lights on and adjust to the desired level.			P27A1 P27B1	
		NOTE: The above tasks are typical for both sextant and stadimeter sighting periods.				
		Midcourse Type Navigation Measurement Using Sextant.				
O 1.0	PLT	Commence experiment operation.				
O 1.1	PLT	Acquire a single known star. Superimpose the image of the star in the sextant line of sight by using scan control knob.			O11A1	

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster)

**TP - Test Pilot (Commander)
OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 5 of 7)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
O 1.1.1	PLT	At the time of superimposition, record voice mark, measure angle for 5 marks, temperature and portion of the window used. NOTE: Operation Step Nos. O 1.1 through O 1.2 are to be performed at the beginning of each sextant sighting period.				
O 1.2	PLT	Acquire a target pair in the sextant line of sight and superimpose the images by using scan control knobs.				
O 1.2.1		At the time of superimposition, voice record, "mark", record chronograph time and elevation angle for 10 marks, target pair, mark number, and portion of window used. NOTE: There are 24 performances (sighting periods) spaced through each mission. Each performance consists of a target pair.				
O 1.3	PLT	Orbit Type Navigation Measurements.				
O 1.3.1	PLT	Voice record time from astronaut's chronograph at the start of each set of stadimeter sightings.				
O 1.3.2	PLT	Identify the best available horizon and set the stadimeter scanning control to the estimated setting.				
O 1.3.3		Insert neutral density filter if required.			O133A1	
O 1.3.4		Align the split images voice "mark", and record measured angle, horizon used and if filter was used. NOTE: A minimum of one performance for SL-2 and five performances per mission on SL-3 and SL-4 are required.				

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster)

**TP - Test Pilot (Commander)
OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 6 of 7)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
O 1.4		Orbit Type Navigation Using Sextant.				
O 1.4.1	PLT	Repeat Operation Step Nos. O 1.1 and O 1.2.				
O 1.4.2	PLT	Acquire selected star and earth horizon with the sextant.				
O 1.4.5	PLT	Superimpose the images in the sextant line of sight by operating scan control knob.				
O 1.4.6	PLT	At the time of superimposition, record "mark" on the voice recorder.				
O 1.4.7	PLT	Voice record time of measurement from the astronaut's chronograph, elevation angle, star used. NOTE: Perform Operation Step Nos. O 1.8 through O 1.9 for TBD marks.				
O 1.5	PLT	Operational Sightings Using a Stadimeter.				
O 1.5.1	PLT	Repeat Operation Step Nos. O 1.3.1 through O 1.3.3.				
O 1.5.2	PLT	Perform first stadimeter sighting upon entering day portion of the orbit.				
O 1.5.3	PLT	Perform second and third stadimeter sighting at minute intervals, after first sighting before entering night orbit. NOTE: At the time of image alignment start the stadimeter stopwatch in addition to the voice mark. At a convenient time on the chronograph stop the stopwatch, voice record stopwatch and chronograph times and measure angle. Reset stopwatch.				
O 1.6	PLT	Sextant Operational Sightings.				
O 1.6.1	PLT	Repeat Operation Step Nos. O 1.1 through O 1.1.1.				

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster)

**TP - Test Pilot (Commander)
OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

TABLE O-III. EXPERIMENT T-002, NAVIGATION SIGHTINGS EVALUATION SEQUENCE (Sheet 7 of 7)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
O 1.6.2	PLT	Acquire first known star and horizon in sextant line of sight, and superimpose the images by using scan control knob.				
O 1.6.3	PLT	At the time of superimposition, record "mark" on the voice recorder.				
O 1.6.4	PLT	Voice record time of measurement and elevation angle for TBD marks, record star used, and mark number.				
O 1.6.5	PLT	Repeat Operation Step Nos. O 1.6.2 through O 1.6.4 for a second star and horizon.				
T 1.0	PLT	Commence experiment termination.				
T 1.1		Turn off the instrument display light.				
T 1.2		Turn off the reticle light.				
T 1.3		Stow the sextant/stadimeter.				
T 1.4		Stow the hood.				
T 1.5		Reinstall wardroom window protective shield.				

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster).

**TP - Test Pilot (Commander)
OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

SECTION VIII.

EXPERIMENT T-002, NAVIGATION SIGHTINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE

TABLE O-IV. EXPERIMENT T-002, NAVIGATION SIGHTINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT PREPARATION (P)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
P 2.6	Turn the instrument readout lamp on.	P26A Readout lamp not lighted.	P26A1 The experiment can be continued using an auxiliary light.	
		P26B Readout lamp illumination switch failure.	P26B1 See Contingency Plan P26A1.	
		P26C Battery discharged.	P26C1 Replace the battery and continue with experiment.	
P 2.7	Turn the reticle lights on and adjust to the desired level.	P27A Reticle lamp not illuminated.	P27A1 Recycle the reticle lamp switch. If the lamp comes on, continue with experiment. If the lamp does not come on, continue the experiment under degraded mode.	
		P27B Reticle switch failure.	P27B1 See Contingency Plan P26C1.	

P

TABLE O-V. EXPERIMENT T-002, NAVIGATION SIGHTINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT OPERATION (O)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
O 1.1	Acquire a single star and superimpose the image of the star in sextant line of sight by using scan control knobs.	O11A Control knob will not move. This indicates a probable seizure of the bearings or gears.	O11A1 If the knob cannot be operated at all, the experiment must be terminated.	
O 1.3.3	Insert a neutral density filter, if required.	O133A Filter control lever does not operate.	O133A1 The experiment can be continued without the use of the filter.	

TABLE O-VI. EXPERIMENT T-002, NAVIGATION SIGHTINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT TERMINATION (T)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
No contingency plans are identified for the Termination section of the experiment at this time.				

T

SECTION IX.

EXPERIMENT T-002, NAVIGATION SIGHTINGS MALFUNCTION ANALYSES

The material contained in this section is an excerpt from Reference 7.

16. MANUAL NAVIGATION SIGHTINGS, T002

The primary T002 operational functions requiring malfunction analysis are presented in Table 16.1. Figure 16.1 depicts the relationships used to develop the table and presents those items analyzed in this issue of the document.

Table 16.1 Operational Functions and Malfunction Analysis Items, T002

Operational Function	Operational Subfunction	Malfunction Analysis Item
16.1 Provide Sextant Data	16.1.1 Provide Lighting	16.1.1.1 Faulty Lamp 16.1.1.2 Battery Discharged
	16.1.2 Provide Scanning	16.1.2.1 Faulty Readout of Readout Drive 16.1.2.2 Faulty Coarse Scan Control 16.1.2.3 Faulty Fine Scan Control
	16.1.3 Provide Optical Filtering	16.1.3.1 Fixed LOS Filter Control Inoperative 16.1.3.2 Scanning LOS Filter Control Inoperative
16.2 Provide Stadimeter Data	16.2.1 Provide Lighting	16.2.1.1 Faulty Lamp 16.2.1.2 Battery Discharged
	16.2.2 Provide Scanning	16.2.2.1 Faulty Readout or Readout Drive 16.2.2.2 Faulty Scan Control
	16.2.3 Provide Optical Filtering	16.2.3.1 Filter Control Inoperative

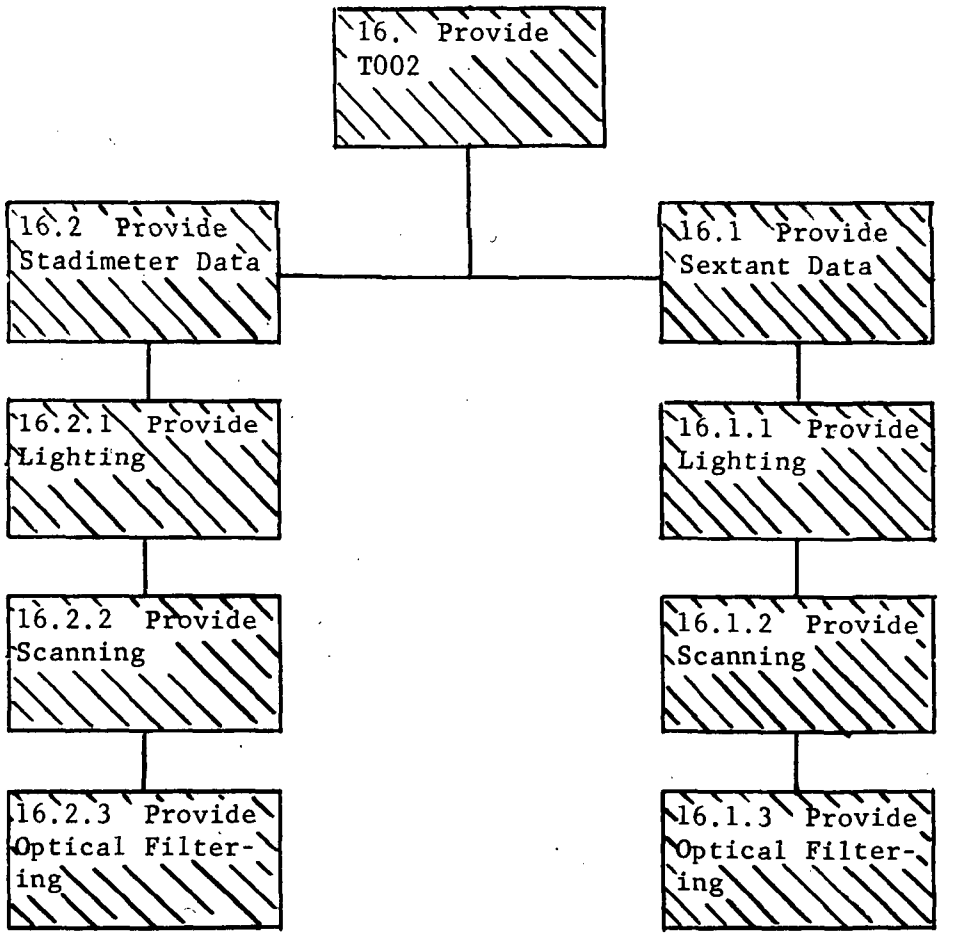

Figure 16.1 Functional Flow Diagram, T002

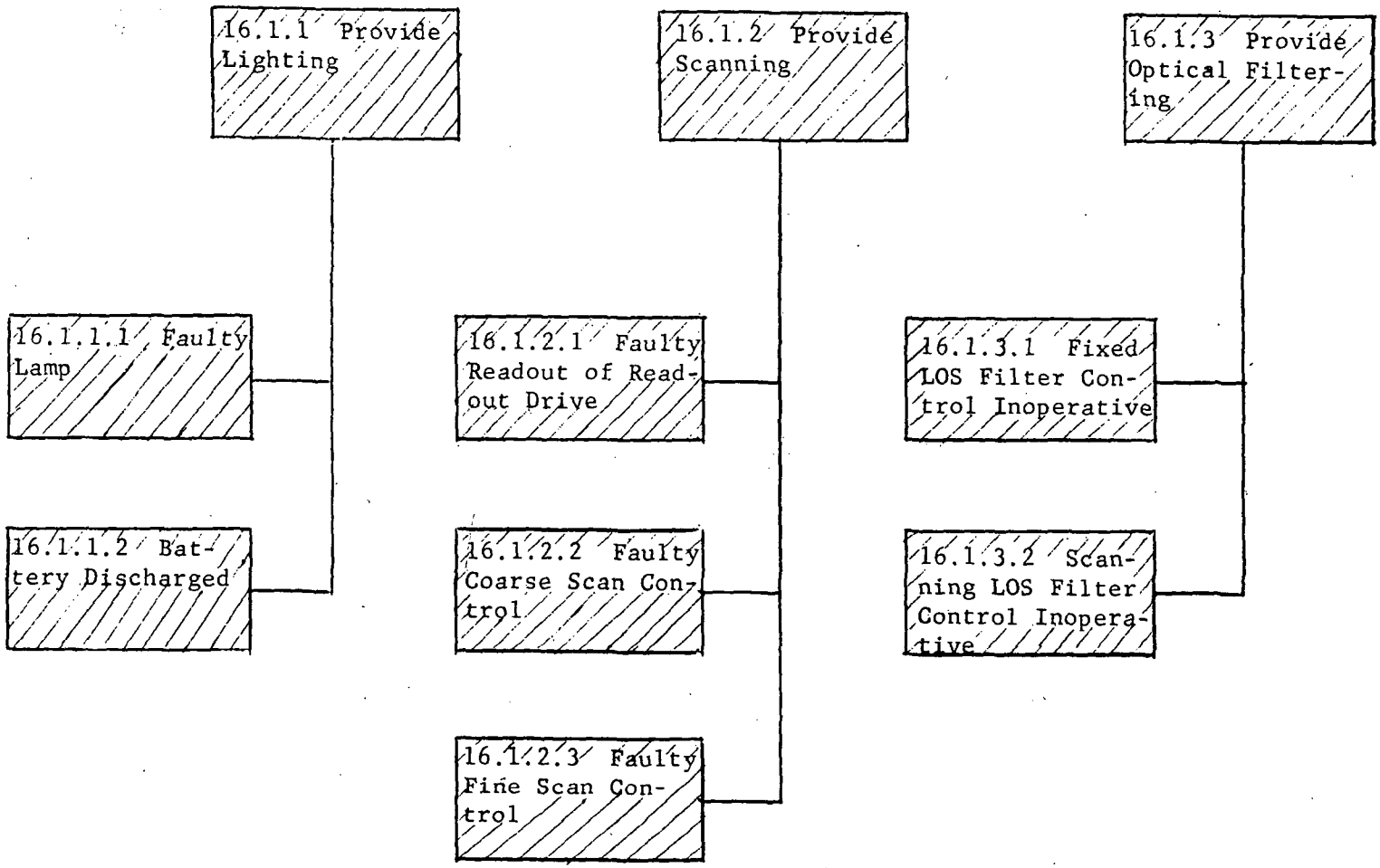

Figure 16.2 Malfunction Analysis Diagram, T002

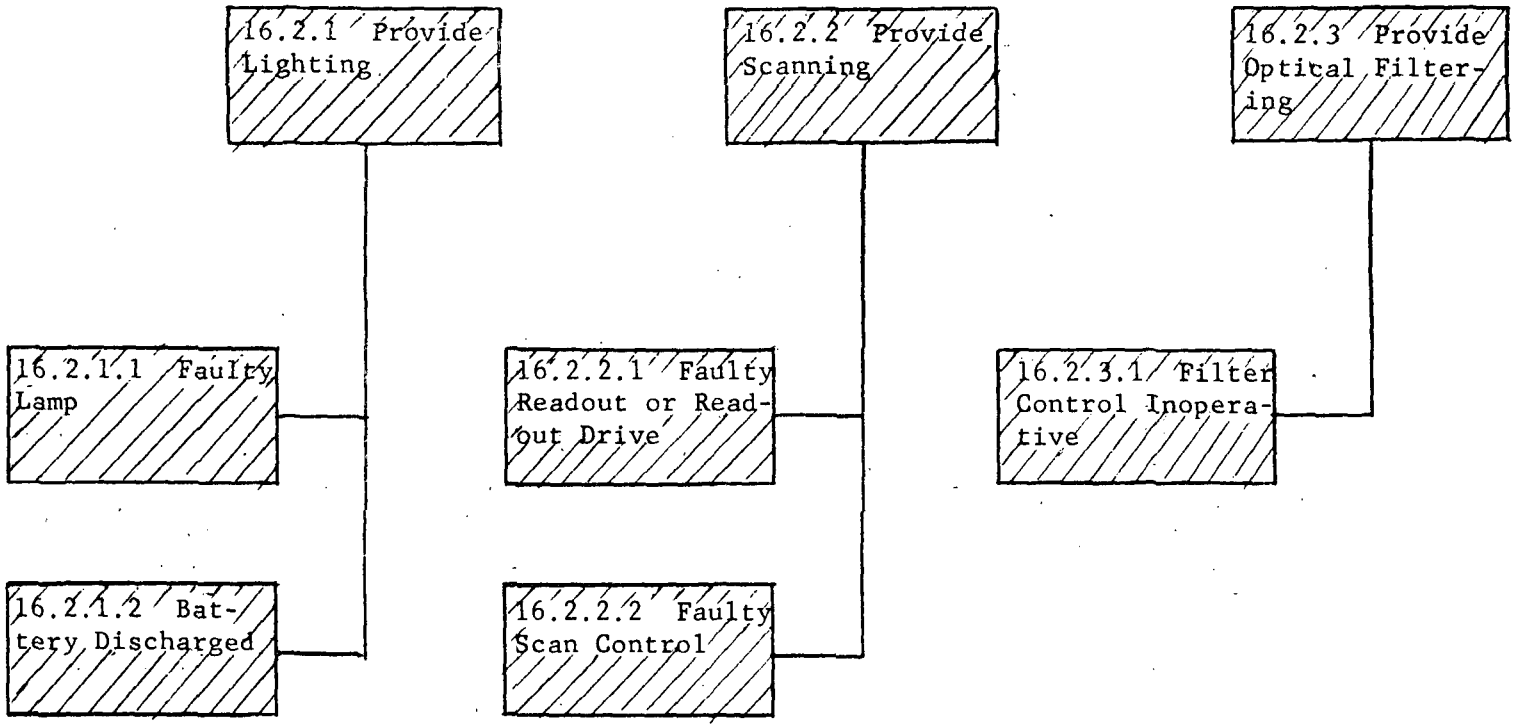

Figure 16.3 Malfunction Analysis Diagram, T002

MALFUNCTION ANALYSIS CHART, T002

MALFUNCTION	INDICATION		EFFECT			ACTION
MALFUNCTION OR CONDITION	PRIMARY MEASUREMENTS	SUPPORT MEASUREMENTS	MISSION/CREW	SYSTEM/SUBSYSTEM	SYSTEM/ INTERACTION	CREW OR COMMAND
16. Provide T002						
16.1 Provide Sextant Data						
16.1.1 Provide Lighting						Ground Action: None Crew Action: Phases D, F, H.
16.1.1.1 Faulty Lamps						
Case I: Reticle Light Burned Out	Reticle light (U): Not lighted with readout light operable.	None	Mission: None Crew: None	Possible limitation of acceptable targets.	None	1. Set reticle sw in another position, and 2. Continue experiment in degraded mode.
Case II: Readout Light Burned Out or Faulty Readout Light Switch	Readout light (U): Not operable with recticle light lighted.	None	Mission: None Crew: Minimal timeline effect.	None	None	1. Continue experiment using auxillary lighting as required to retain accuracy.
16.1.1.2 Battery Discharged	Readout light (U): Not operable. Reticle light (U): Not lighted	None	Mission: None Crew: None	None	None	1. Replace batteries and continue experiment.
16.1.2 Provide Scanning						Ground Action: None Crew Action: Phases D, F, H.
16.1.2.1 Faulty Readout or Readout Drive	Crew Observation, (U): Readout does not change with adjustment of scan controls, view in viewer acceptable.	None	Mission: None Crew: Minimal timeline effect.	Loss of subsequent sextant data.	None	1. Terminate sextant portion of experiment nominally.
16.1.2.2 Faulty Coarse Scan Control	Crew Observation, (U): Control will not move.	None	Mission: None Crew: None	Possible limitation of acceptable targets.	None	1. Continue experiment with targets within the fine scan range.

MISSION PHASES: A. All Phases
B. Boost to Orbit
C. Activation
D. 1st Visitation
E. 1st Storage
F. 2nd Visitation
G. 2nd Storage
H. 3rd Visitation

MALFUNCTION ANALYSIS CHART, T002

MALFUNCTION	INDICATION		EFFECT			ACTION
MALFUNCTION OR CONDITION	PRIMARY MEASUREMENTS	SUPPORT MEASUREMENTS	MISSION/CREW	SYSTEM/SUBSYSTEM	SYSTEM/ INTERACTION	CREW OR COMMAND
16.1.2.3 Faulty Fine Scan Control	Crew Observation, (U): Control will not move.	None	Mission: None Crew: None	Loss of fine scanning control.	None	1. Continue experiment with as fine adjustment as the coarse scan control will allow.
16.1.3 Provide Optical Filtering						Ground Action: None Crew Action: Phases D, F, H.
16.1.3.1 Fixed LOS Filter Control Inoperative	Crew Observation, (U): Control will not move.	None	Mission: None Crew: None	Possible limitation of usable targets.	None	1. Continue experiment with targets within the instrument capability.
16.1.3.2 Scanning LOS Filter Control Inoperative	Crew Observation, (U): Control will not move.	None	Same as 16.1.3.1	Same as 16.1.3.1	None	Same as 16.1.3.1
16.2 Provide Stadimeter Data						
16.2.1 Provide Lighting						Ground Action: None Crew Action: Phases D, F, H
16.2.1.1 Faulty Lamp						
Case I: Reticle Light Burned Out or Reticle Light Pot Failed Open	Reticle Light, (U): Not lighted with readout light operable.	None	Mission: None Crew: None	Possible limitation of acceptable targets.	None	1. Recycle pot, and 2. Continue experiment in degraded mode.
Case II: Readout Light Burned Out or Faulty Readout Light Switch	Readout Light, (U): Not operable with reticle light lighted.	None	Mission: None Crew: Minimal timeline effect.	None	None	1. Continue experiment using auxiliary lighting as required to maintain accuracy.
16.2.1.2 Battery Discharged	Readout Light, (U): Not operable Reticle Light, (U): Not lighted.	None	Mission: None Crew: None	None	None	1. Replace batteries and continue experiment.

MISSION PHASES:
A. All Phases
B. Boost to Orbit
C. Activation
D. 1st Visitation
E. 1st Storage
F. 2nd Visitation
G. 2nd Storage
H. 3rd Visitation

MALFUNCTION ANALYSIS CHART, T002

MALFUNCTION	INDICATION		EFFECT			ACTION
MALFUNCTION OR CONDITION	PRIMARY MEASUREMENTS	SUPPORT MEASUREMENTS	MISSION/CREW	SYSTEM/SUBSYSTEM	SYSTEM/ INTERACTION	CREW OR COMMAND
16.2.2 Provide Scanning						Ground Action: None Crew Action: Phases D, F, H
16.2.2.1 Faulty Readout or Readout Drive.	Crew Observation, (U): Readout does not change with adjustment of scan controls, view in viewer acceptable.	None	Mission: None Crew: None	Loss of subsequent Stadimeter data.	None	1. Terminate Stadimeter portion of experiment nominally.
16.2.2.2 Faulty Scan Control	Crew Observation, (U): Control will not move.	None	Mission: None Crew: None	Possible limitation of acceptable targets.	None	1. Continue experiment with targets within the instrument capability.
16.2.3 Provide Optical Filtering						Ground Action: None Crew Action: Phases D, F, H.
16.2.3.1 Filter Control Inoperative	Crew Observation, (U): Control will not move.	None	Mission: None Crew: None	Possible limitation of usable targets.	None	1. Continue experiment with targets within the instrument capability.

MISSION PHASES: A. All Phases
B. Boost to Orbit
C. Activation
D. 1st Visitation
E. 1st Storage
F. 2nd Visitation
G. 2nd Storage
H. 3rd Visitation

SECTION X. CONCLUSIONS AND RECOMMENDATIONS

1. An analysis of the experiment revealed that no high probability of failure of the hardware components exists. If a failure should occur, it would result in Category III failure. The probability of success is improved by the fact that this experiment has been successfully operated in Gemini spacecraft missions.

REFERENCES

1. Skylab Program Directive No. 43B (Operation Directive). February 14, 1972.

2. Mission Requirements Document SL-1/SL-2, SL-3 and SL-4 Missions. Document No. I-MRD-OOIE, Vol. I, November 1, 1971.

3. Experiment Requirements Document for Experiment T-002, Navigation Sightings. SE-010-037-2H, August 9, 1971.

4. Skylab Flight Plan. Rev. A, September 27, 1971.

5. PCSN to MRD. CCBD No. 800-72-0013, March 3, 1972.

6. Skylab Experiment Operations Handbook. Vol. I, Manned Spacecraft Center, Houston, Texas, November 19, 1971.

7. Wilcoxson, C. B., et al: Mission Operations Design Support, Volume III. OWS Experiments Malfunction Analyses, Rev. A, ED-2002-1244, Martin Marietta Corporation, Denver, Colorado, May 12, 1972.